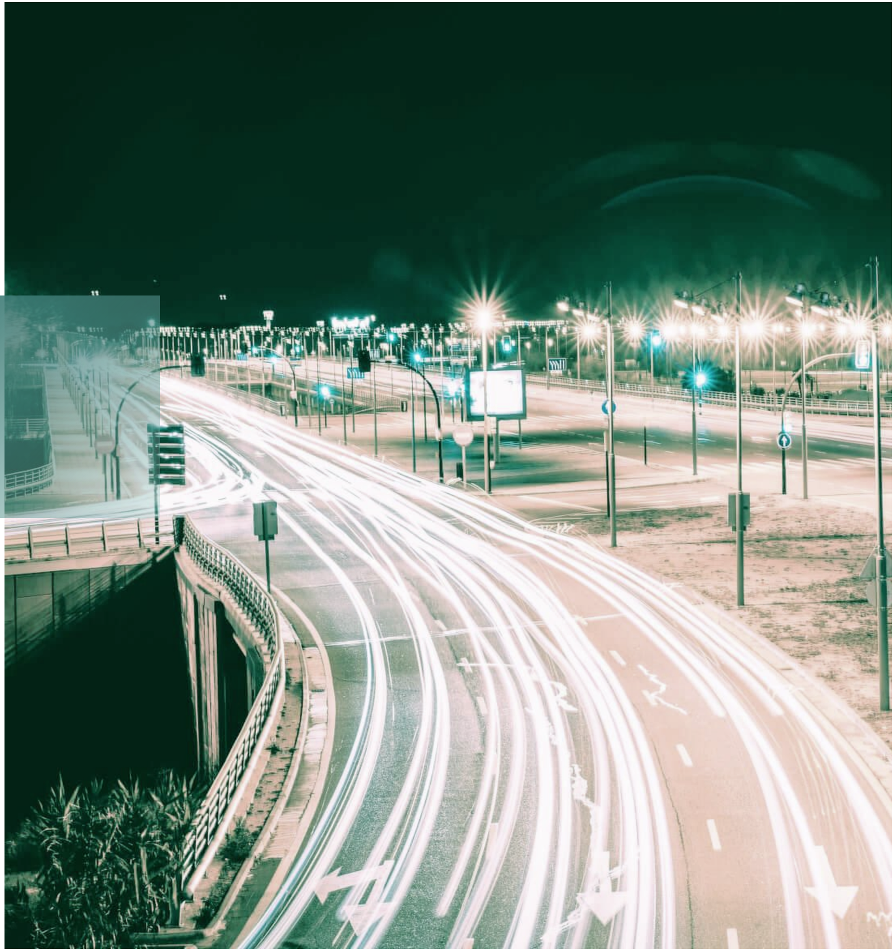
Mobile Payments

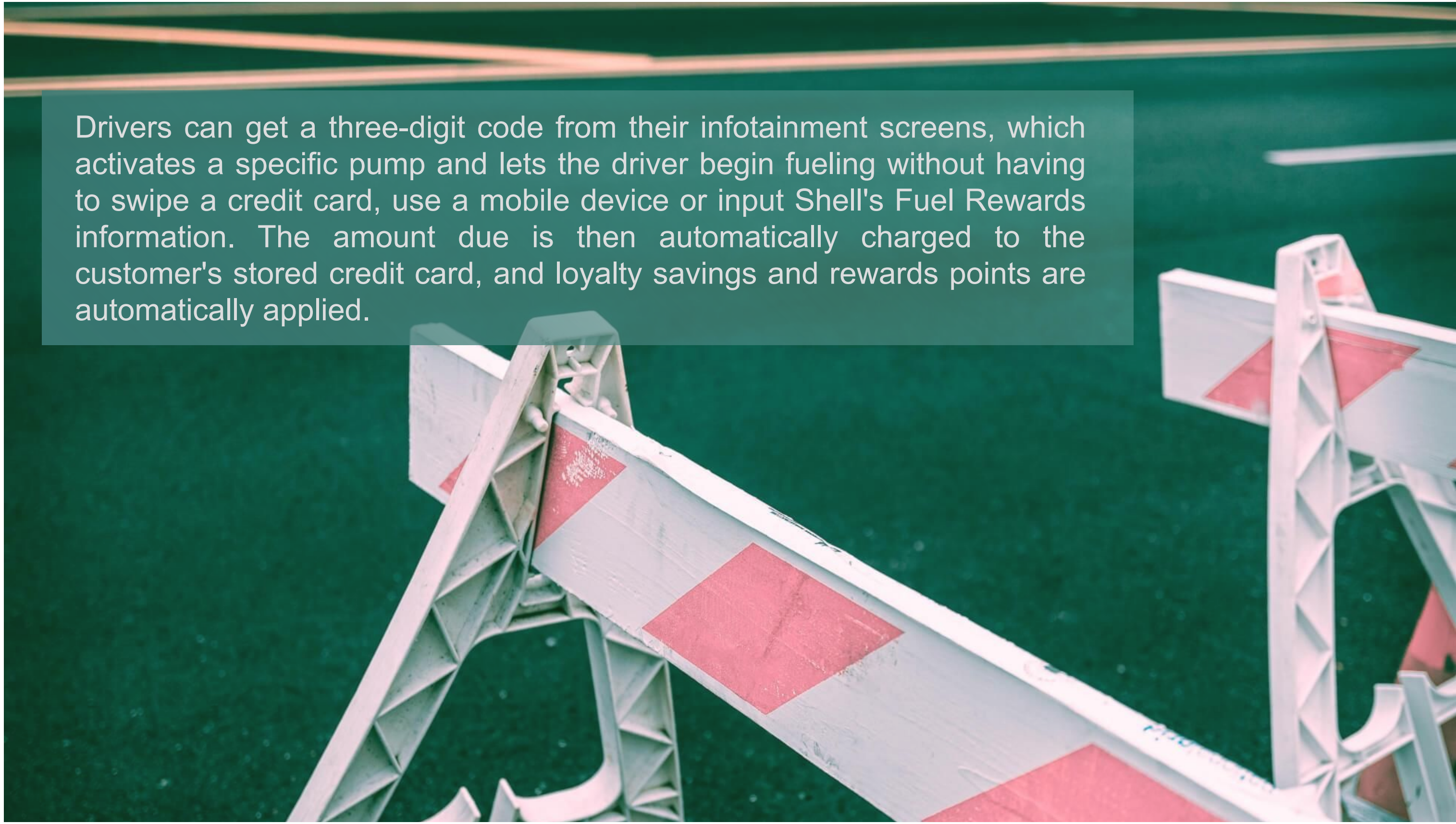
With a focus on IOT technologies for in-vehicle payment



ABOUT THE PROJECT

In-vehicle payment services crucially enable automobile drivers to purchase from their car dashboards without utilising smartphones or other devices: the vehicle will facilitate the payment itself.

DAILY USAGE



Drivers can get a three-digit code from their infotainment screens, which activates a specific pump and lets the driver begin fueling without having to swipe a credit card, use a mobile device or input Shell's Fuel Rewards information. The amount due is then automatically charged to the customer's stored credit card, and loyalty savings and rewards points are automatically applied.

Investments in Western Countries

Name	Type	Technology	Investment	Country
Teradata	Company	AI	-	USA
Sibros	Company	IOT	15.5 M	USA
IBM	Company/RC	IOT	*6.3 B (2020 R&D investment)*	USA
GeneralMotors/Shell	Company/Partnership	IOT	6.8 B (2019 R&D investment GM)	USA
SiriusXM/Visa	Company/Partnership	IOT	-	USA

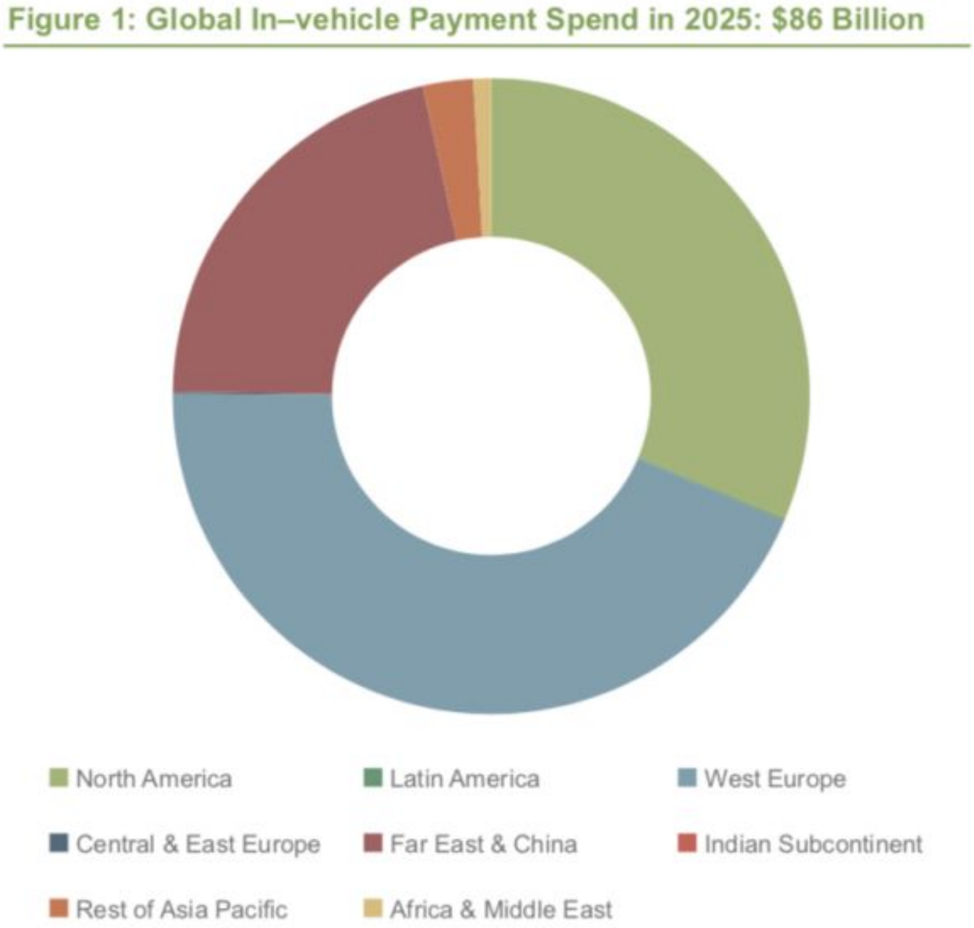
Investments in EU

Name	Type	Technology	Investments	Country
Mastercard/Daimler	Company/Partnership	IOT	9.7 B (Daimler R&D investments)	USA/Germany
Mastercard/HERE	Company/Partnership	IOT	-	USA/Netherlands
Keyble/Flywallet	Startup	Biometrics	56.2K	Italy
Vuolly	Failed Startup	Blockchain	0	Italy
Feedzai	Company	AI/Fraud detection	77.5M	Portugal
V2X	Company	IOT	-	England
Shell/Fiat	Partnership	IOT	*1 Billion (in R&D 2019 SHELL) + 3.6B (R&D fiat 2019)*	Italy/Netherlands

Investments in Asia

Name	Type	Technology	Country
Hyundai/Texaco	Company	IOT	South Korea
Honda/Connected Travel	Company	IOT	Japan
Honda/Visa	Company	IOT	Japan

No information was found about the amount of these investments



Projected Growth of In-Vehicle payments by Country in 2025

Who is financing research?

- Industry partnerships
- US based venture capitalists

Are investments growing?

- **Sibros**:
  before: “seed”investment type ($ 10k-$2M,
  After: “Series A” investment type ($1M-$30M).

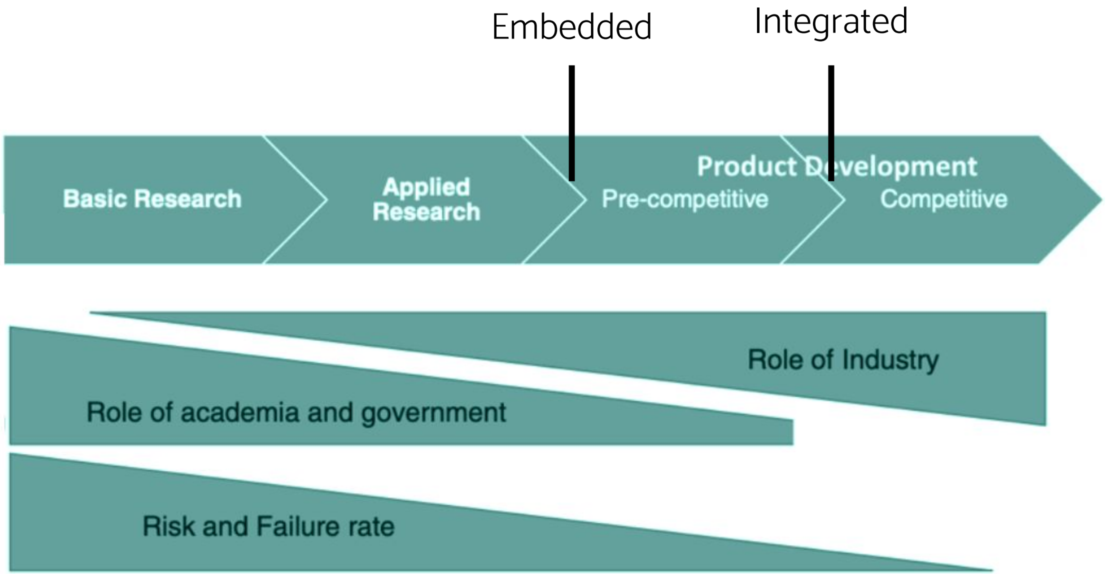
What is the amount of such investments?

- **PayByCar:** $ 2M (Convertible note type)
- **V2X Network:** $150 K (Pre-seed type)
- **Sibros:** $15.5 M (Seed-Series A type)

The linear model of innovation

Innovation phase

IOT for in-vehicle mobile payments technologies are in between the applied research phase and the pre-competitive one. Even though the main players are companies (there are also some research centers), they are still trying to explore this technology experimenting different solutions.



In-vehicle payments

Possible growth strategies

The most promising one is the collaboration between different companies belonging to different industries/sectors since combining different core competences could be the key of growth for this technology. It is expected to see large growth of in-mobile payments in regions like North America because of the cross industry collaboration between automakers and payment providers (like Visa, MasterCard). A secure infrastructure for the transactions is vital for this technology and it will enable synergies also between fuel pump manufacturers, parking products providers and many other complementors in order to build a new connected ecosystem.

Policy making and regulations

An important role is also played by governments and institutions. There is a massive collection of data and other technologies, such as biometric identification (for making transaction), can be embedded with in-vehicle mobile payments. It is fundamental to develop standards for this technology and to collect appropriately the data, keeping in mind that different regions could have different regulations.

Pre-existing services

- Android Auto (Google Pay)
- carPlay (Apple Pay)

These popular integrated systems already enable drivers/owners to pay for services while staying inside the car. In-vehicle payments technologies aim to integrate these services inside the dashboard of the car without utilising smartphones or other devices. If we combine the fact that it is actually possible to pay for services with mobile devices staying inside the car and that, traditionally, the core competence of automakers do not reside in making secure transaction systems, this technology has still a moderate risk in terms of investments.

Externalities

Positive	Negative
• During a pandemic like Covid-19 reduces the risk of virus spreading by incrementing distances and avoiding direct or semi-direct contacts	• Induction to stay more in cars -> pollution (NLP training servers and internet consumption), accidents (everything inherited by cars)
• Could reduce pollution and waiting-time (es tolls and drive-ins)	• Could reduce the number of available work positions
	• Higher risks related to privacy and data protection
	• Higher risk of fraudulent transactions
	• Reduction of social interactions (human)

Technological Knowledge and Organizational learning

Old technology : integrated systems			New technology: embedded systems		
Factual Knowledge	Causal Knowledge	Procedural knowledge	Factual Knowledge	Causal Knowledge	Procedural Knowledge
• Other in vehicle payments • Automated toll road payments • Existent standards and regulations	• Versatility • Security • Convenience • Portability • Retro compatibility	• Computer networks (5G) • Human computer interaction • Cross-platform programming • Data management • Mobile application development	• Automated toll road payments • Fuel/electric vehicle charging payments • Smart parking payments • Other in-vehicle payments	• Security • Traceability • Convenience • Positioning & branding • Profitability • Compatibility	• Computer networks (5G) • Embedded Systems • E-commerce • Automotive engineering • Human computer interaction • Data management

History of Main Players

2014
Apple releases CarPlay

2015
Android Auto comes out

January 2018
Honda and Visa partner for an in-vehicle payment solution

August 2018
GM and Shell partnership:
in-vehicle fuel payment
pre-purchase drinks
pre-book restaurants

2019
Mastercard and Here partnership:
Develop next generation of connected next vehicle services

January 2019
Honda & Connected Travel:
Dream drive, integrated vehicle services dashboard

January 2019
Visa & Sirius XM:
In vehicle gas, movie tickets, coffee purchase.
Locate and pay parking

2020
Mastercard & Daimler investment in Fintech Thinxnet subsidiary of Ryder:
In vehicle fuel and tolling marketplace

Competences in the field

Infosec

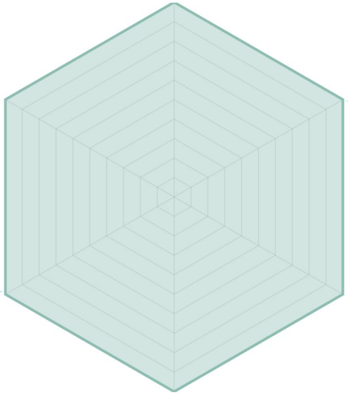
Important in order to have customer trust and secure transactions

Online Transactions

Online transactions further augment the scope of what in-vehicle payments can do thus increasing the value provided by the product.

Software

It is crucial to design software that is efficient and reliable to have a leg up in the market. This is particularly significant when dealing with integrated systems



Automotive

Companies need to know the environments onto which they deploy these systems in order seamlessly merge the car experience with the newer features that they want to introduce.

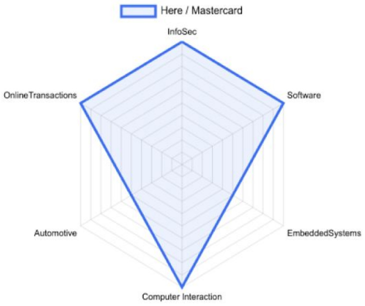
Embedded Systems

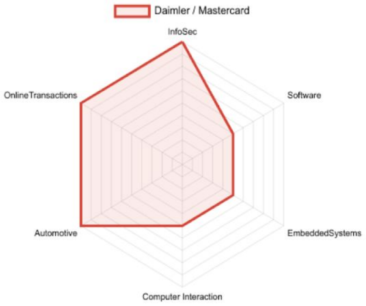
In vehicle payments through embedded systems obviously need to have this skill.

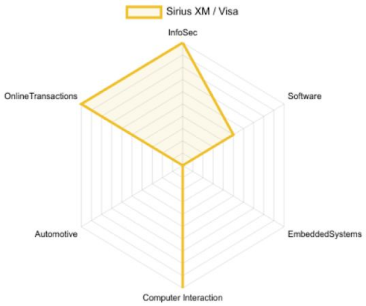
Computer Interaction

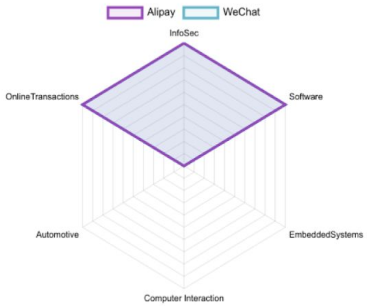
One of the gripes customers have with integrated systems is the difficulty in interacting with the buggy interfaces. If embedded systems want to succeed this is necessary as an important competence

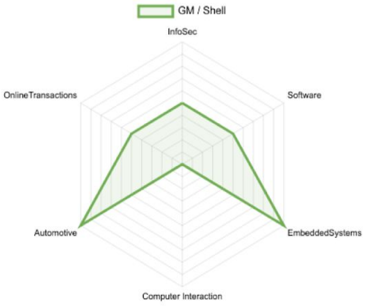
Competences of Current Players

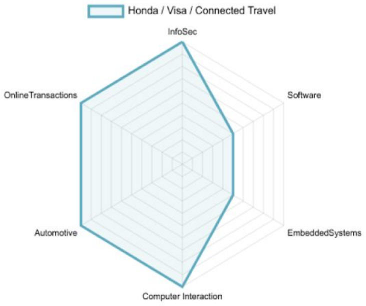


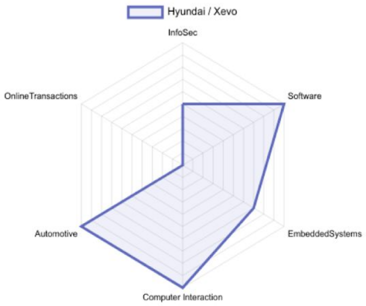


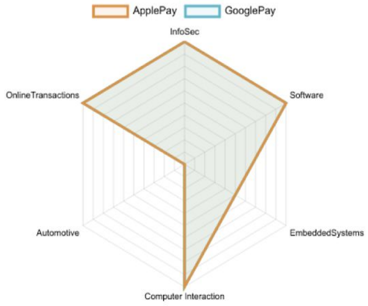






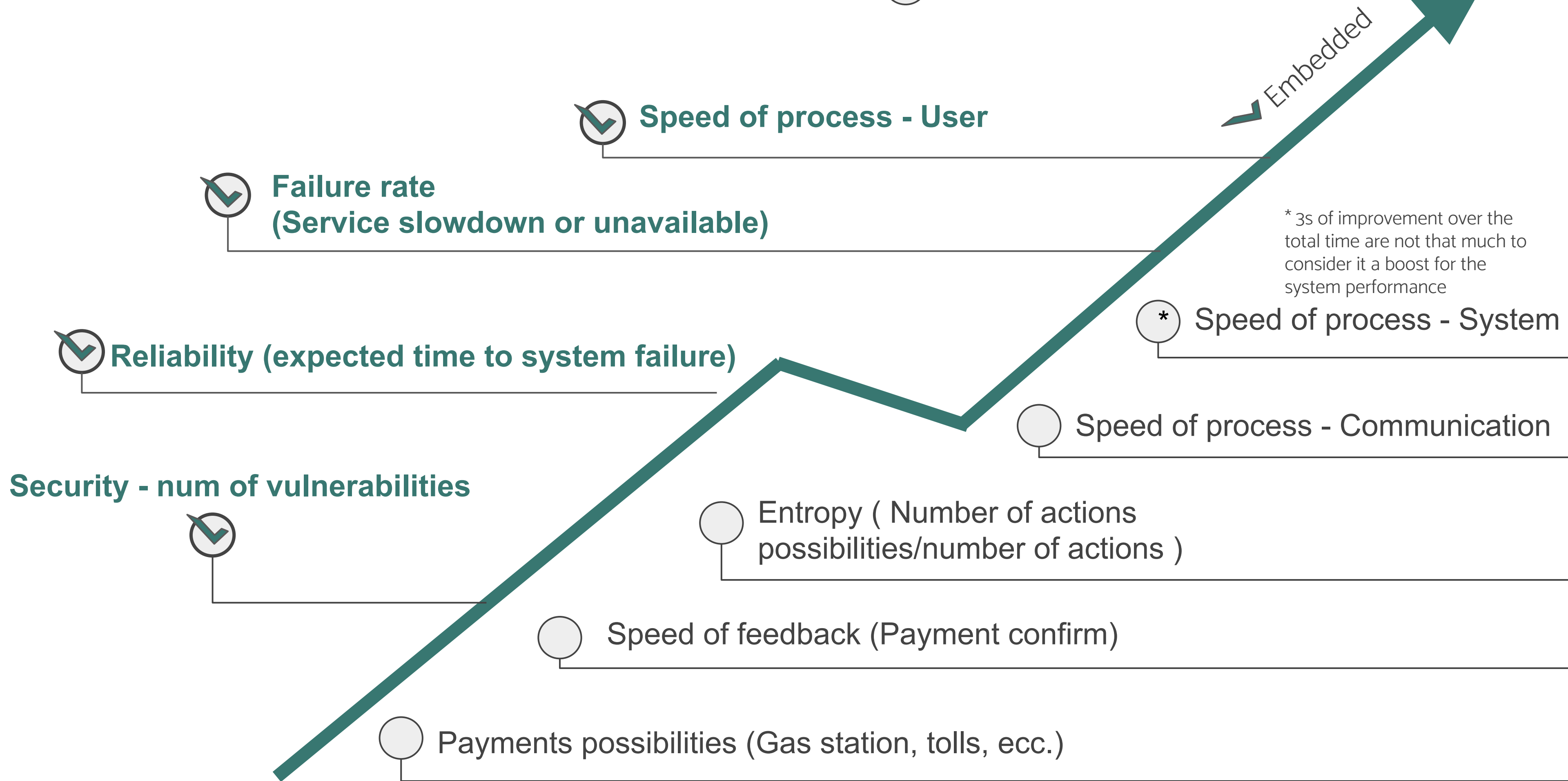


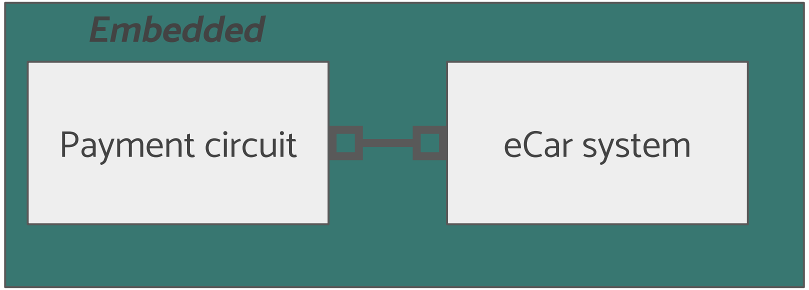




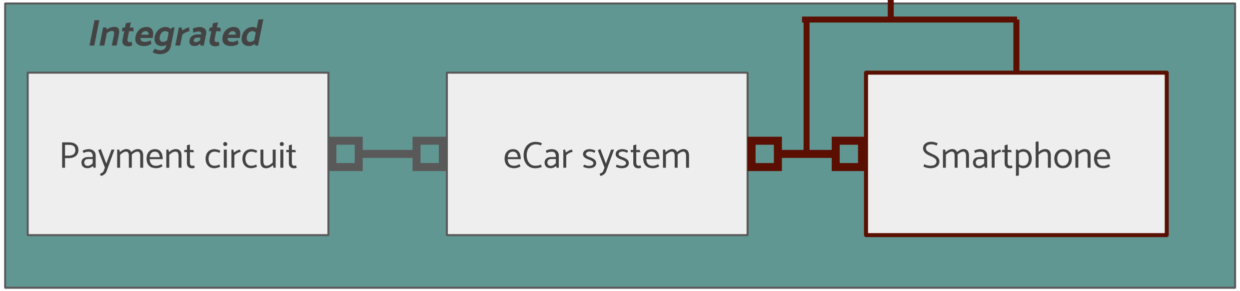
Performances y-axis

Improving
Invariant





- Speed User: It embraces the time spent by a user to make a transaction.
- Failure Rate: It involves a slowdown or a temporary unavailability of the service, e.g. payment that takes 2 hrs, or transaction failed.
- Security: The security of a system is dependent on how many PoA are available, the cost of breaching and the system design. To simplify it we consider the number of possible vulnerabilities.
- Reliability: It is linked to the expected time of the car system failure which requires the technical assistance.



The main improvements are due to the system architecture:

- <u>The smartphone connection is a weak and vulnerable part removable with the embedded technology.</u>

- **Speed:** *login and smartphone-car connection spared: 15s / 3 min → 2s*

- **Security:** *Mobile apps represent 13% of cyber attacks performed, Gartner stated that approx 75% of mobile apps fail basic security tests.*
*On average in the world there are 80 installed apps for each smartphone. Given V the vulnerability (each V is the sum of the vulnerabilities inside the component (e.g. 1 installed app on smartphone is 0.75% vulnerable → 0.75 added to the system). In the end the approx of the difference coincide with the smartphone vulnerabilities. 0.75 * 80 = 60 which increases over time.*

$$\sum_{x\in PoA_{integrated}} V_{int}[x] - \sum_{x\in PoA_{embedded}} V_{emb}[x] = V[car-smartphone] + V[smartphone]$$

Similar considerations are applied to the failure rate and reliability

- **Failure rate:**

$$FR = \frac{\sum_{x\in PoA} failures[x]}{\sum transactions}$$

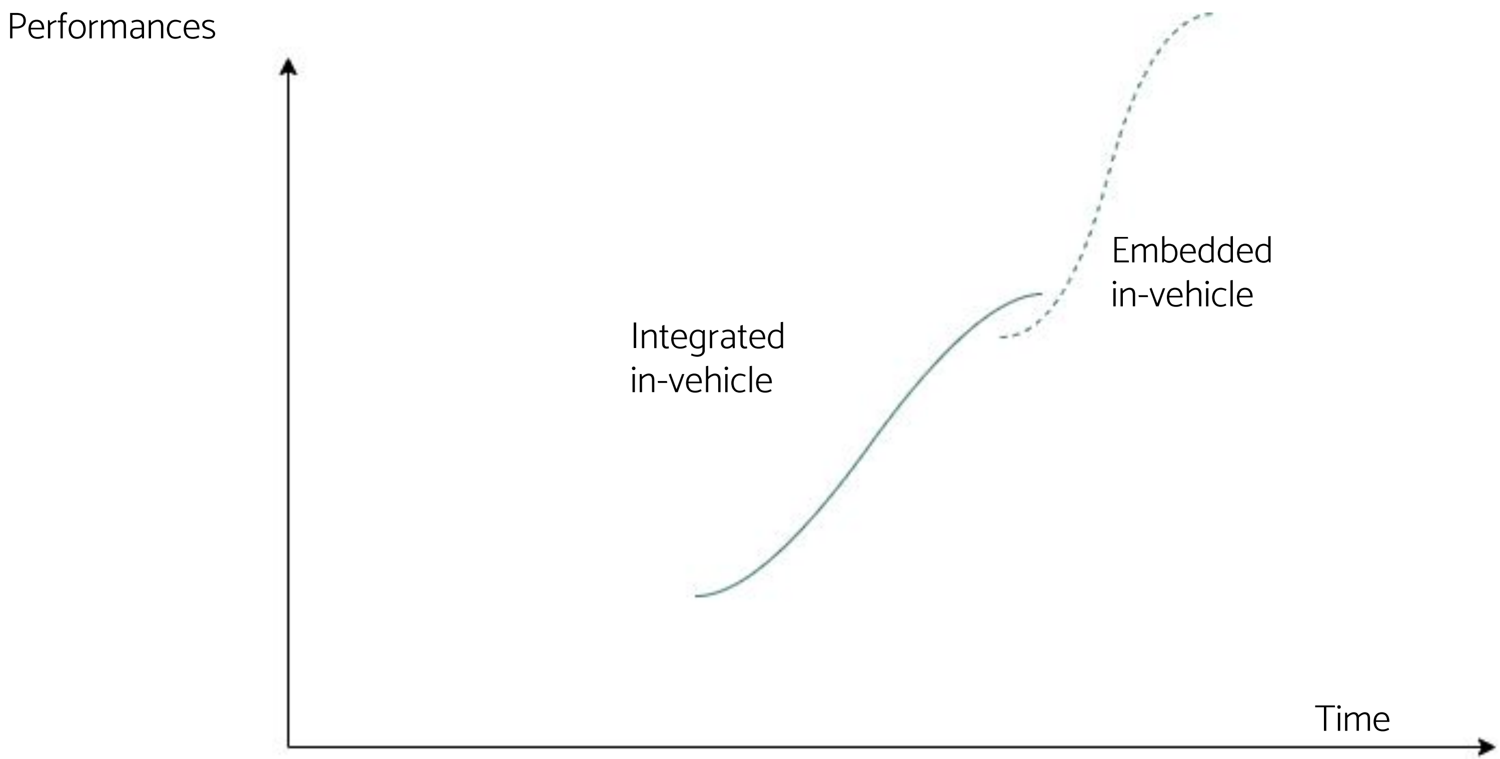
Again the difference lies into the failures of the smartphone and most of all the connection. Android and iOS BLE connection fails are near 13% which is a good approx of the decreasing factor

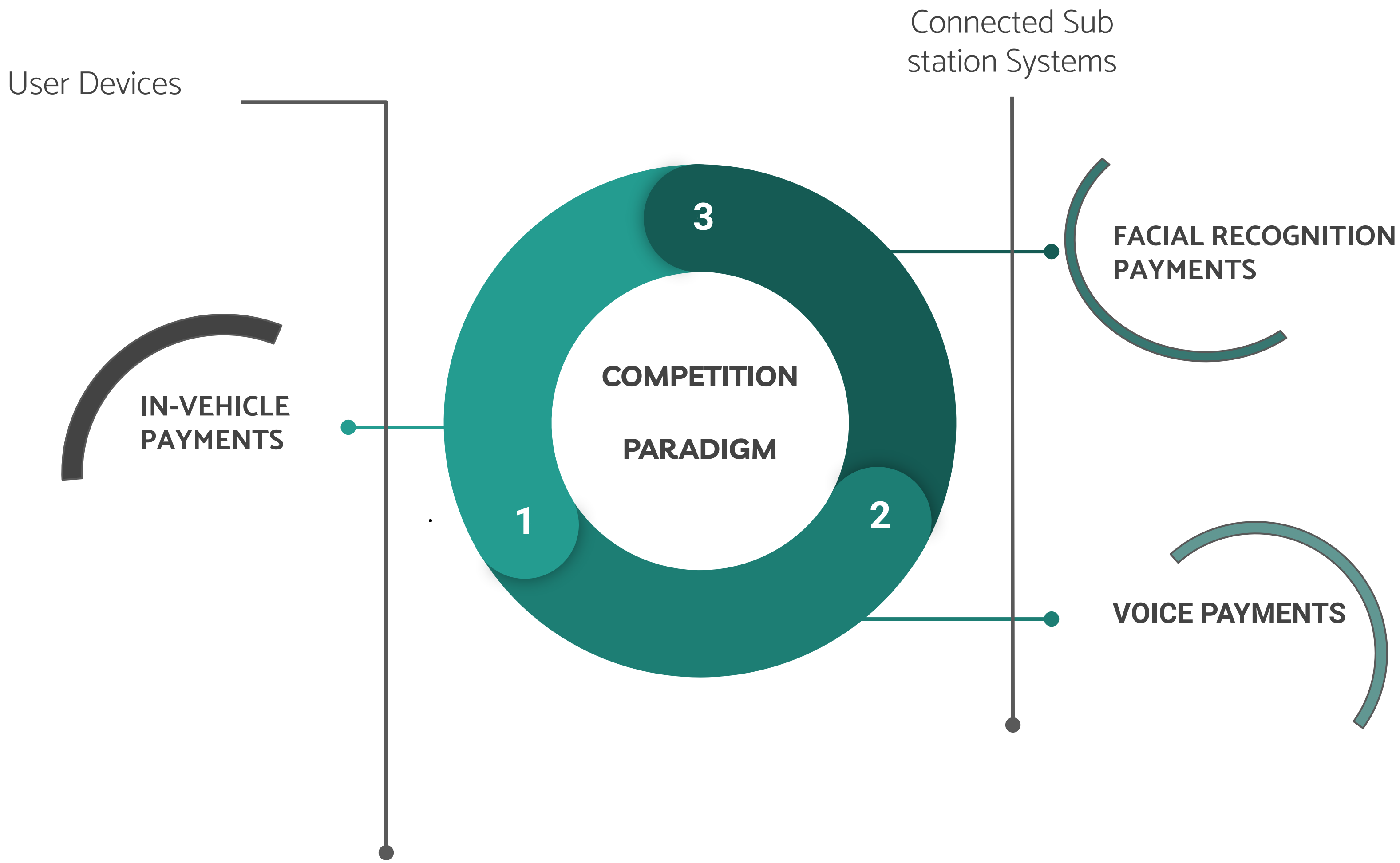
- **Reliability**:

$$E(t) = \int_0^\infty t f(t) dt$$

Where f(t) represents the probability of failures in a number t of transactions. It is proportional to the failure rate quantity. It is highly dependent on the system updates, we can simplify it by considering the number of IT systems multiplied by the rate of update → drastic reduction

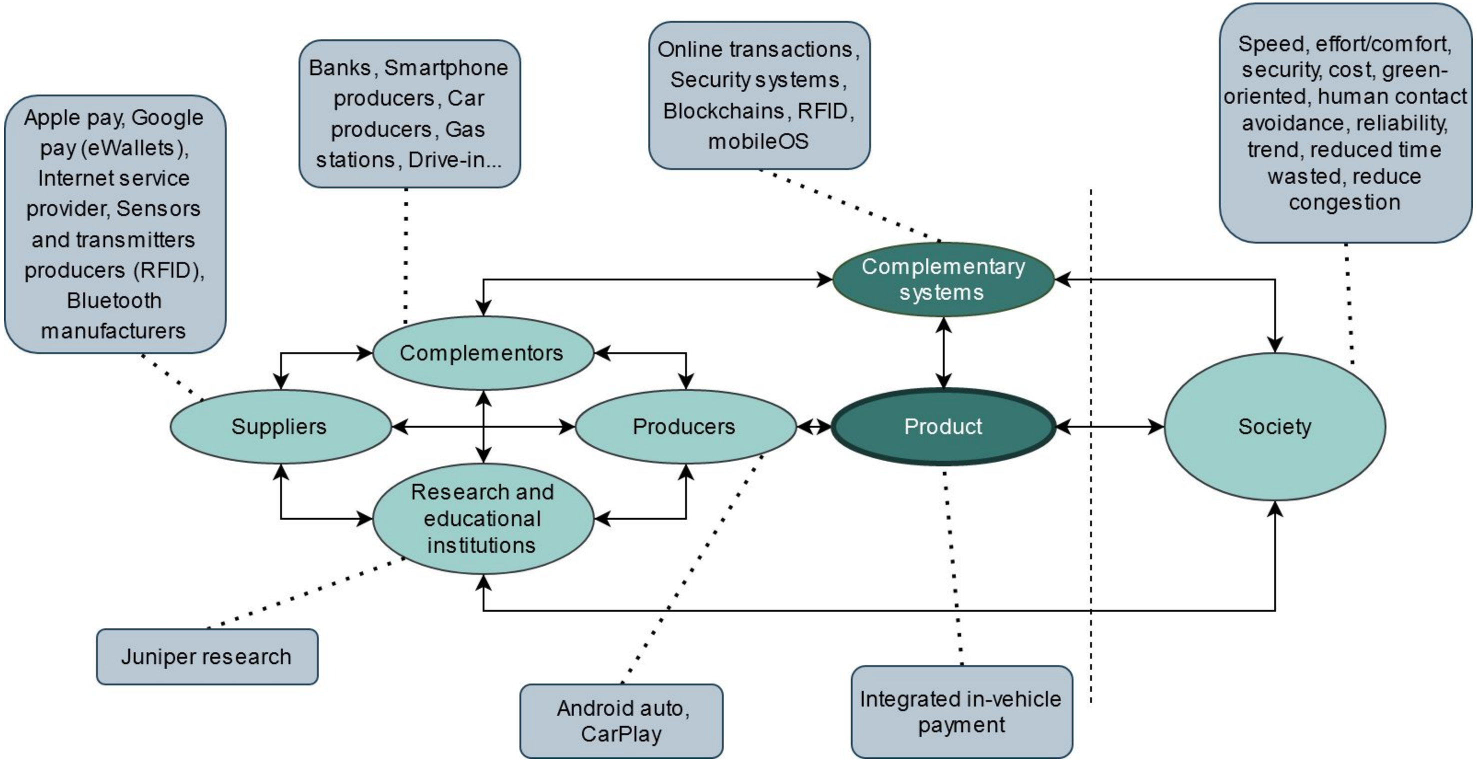
S-curves' plotting



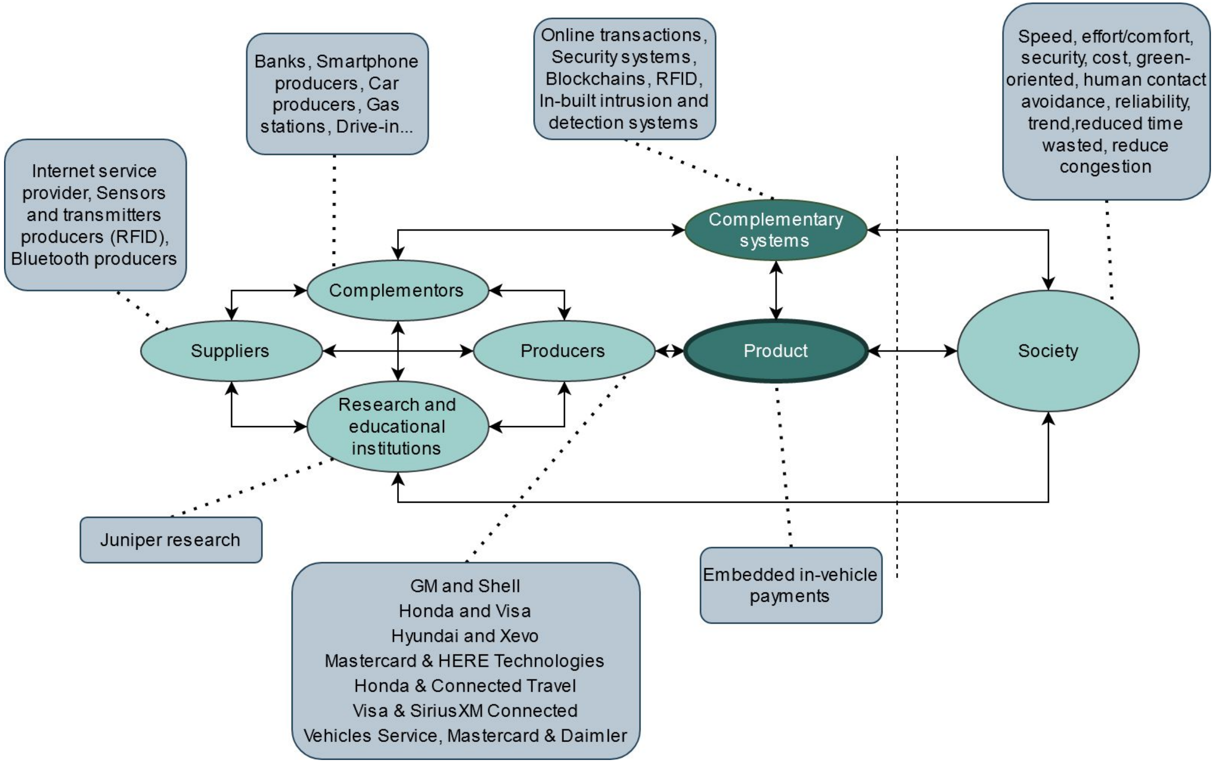


User Devices
Connected Sub station Systems
3
FACIAL RECOGNITION PAYMENTS
IN-VEHICLE PAYMENTS
COMPETITION
PARADIGM
1
2
VOICE PAYMENTS

Previous/current paradigm environment



Current/next paradigm environment



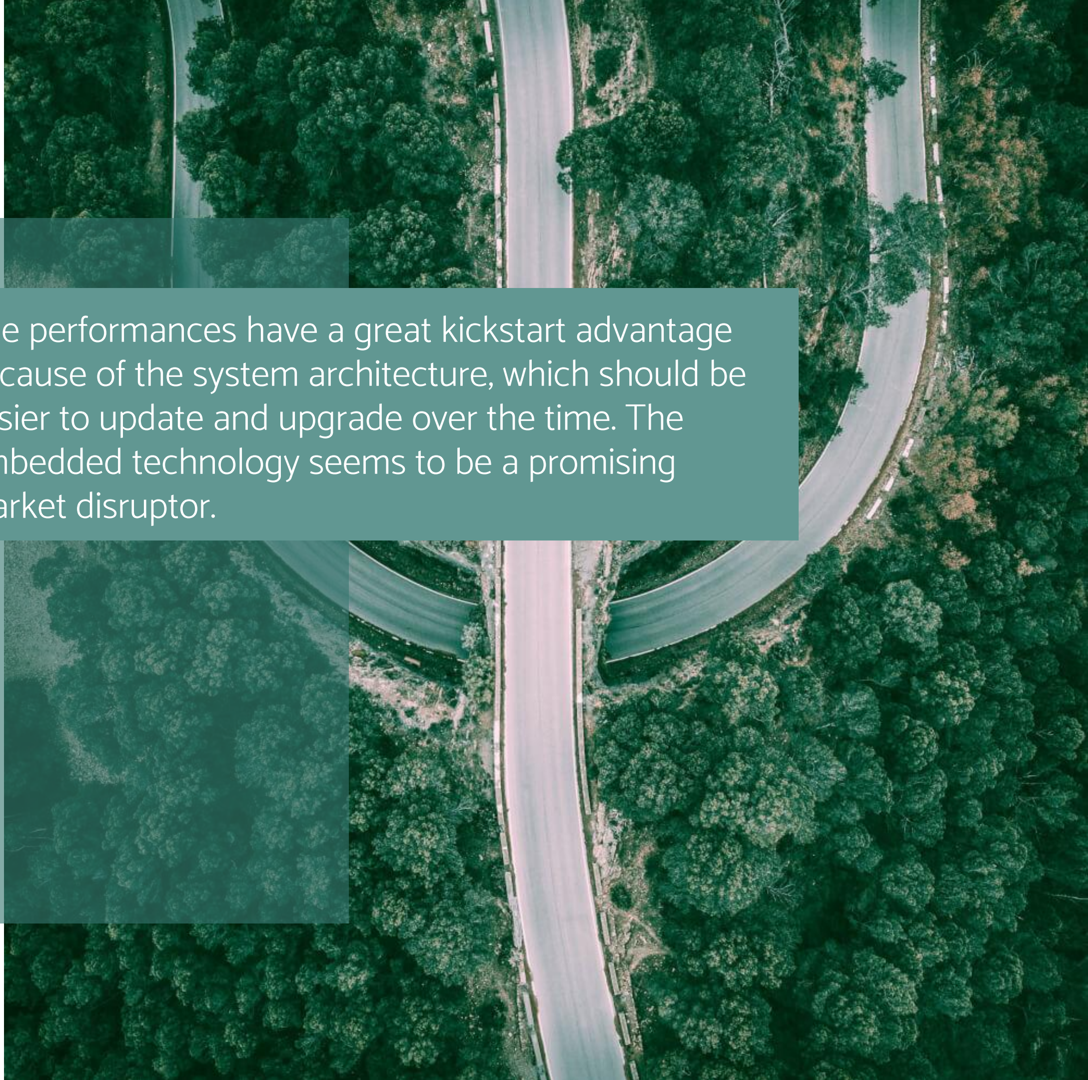
TAXONOMY OF INNOVATION

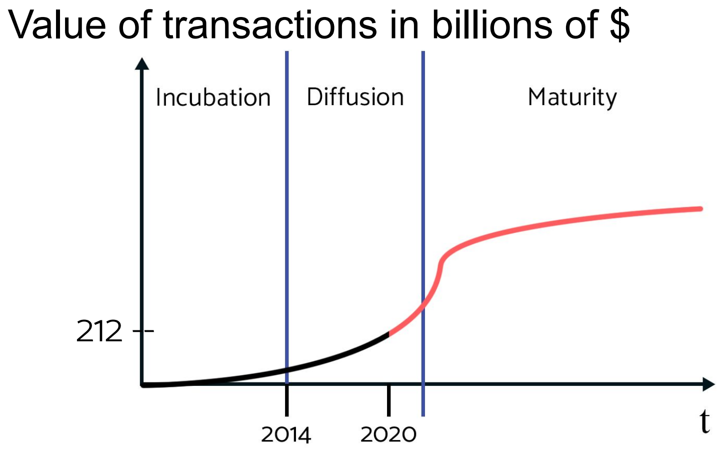
01	Product vs process	Product
02	Incremental vs radical	Radical
03	Competence enhancing vs destroying	Competence destroying
04	Architectural vs component	Architectural
05	Core vs peripheral	Peripheral
06	Sustaining vs disruptive	Disruptive

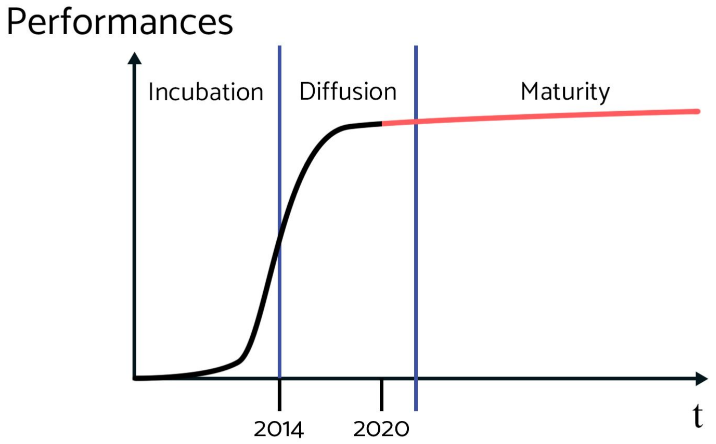
POSSIBLE DISRUPTION IN THE MARKET

The performances have a great kickstart advantage because of the system architecture, which should be easier to update and upgrade over the time. The embedded technology seems to be a promising market disruptor.

Many rumors echoing the investigation of Juniper research announce a market disruption by the embedded in-vehicle payments, that would reach 86 billion dollars in 2025 (up from 543 millions 2020). Anyway should be considered the possibility of the disruption of biometric payments (such as cameras/face recognition payments, voice payments) that could disrupt this technology too.







Diffusion curves for integrated systems

Estimating the diffusion curve from sales data

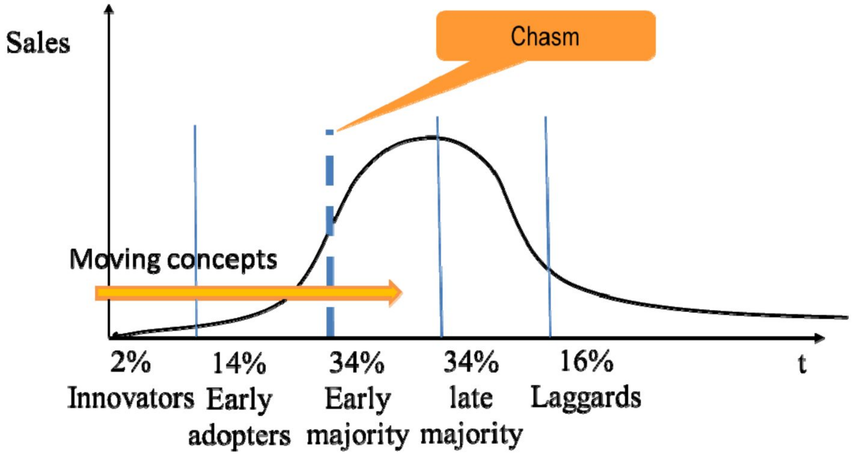
We are considering the traditional technology of mobile payments applied to in-vehicle integrated mobile payments systems. The diffusion phase of these applications started around 2014-2015 (CarPlay integrated in Ferrari and Android Auto integrated into Hyundai) and this technology is reaching maturity.

The red part of the curves represents what predictions think the future trend will be. The companies involved (Google, Apple, etc...) are main players in the sector, therefore, this technology could reach maturity. Of course, there are new technologies emerging, like the embedded in-vehicle payments that represent a direct competition.

The Digital Drive Report 2019, published by PYMNTS, estimates that commuters are already spending $212 billion a year conducting commerce in their cars.

Crossing the chasm

There is a sort of chasm in the diffusion of a service or a product between early adopters and the early majority.
Innovative technological companies usually face difficulties in crossing that chasm because selling a product or a service to innovators or enthusiasts is different from selling it to a major segment of the population since it requires readaptation.

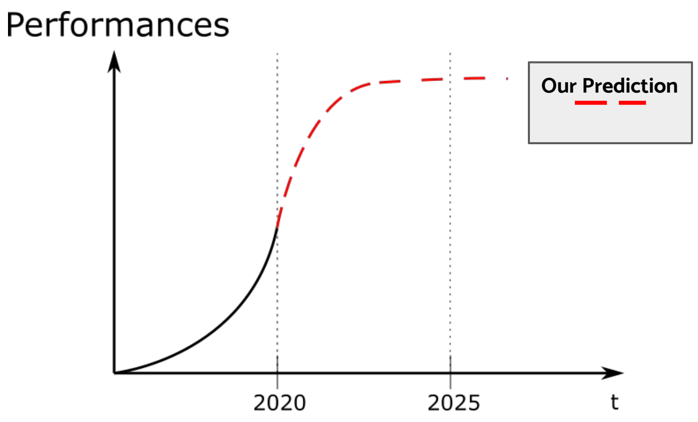


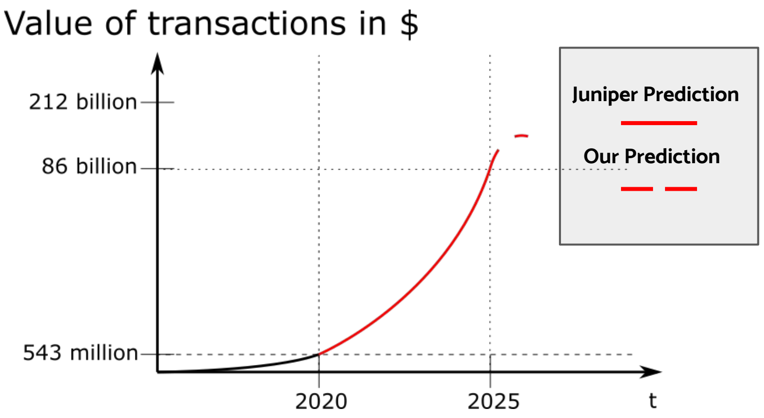
In order to be able to reach this early majority, it is necessary to reevaluate the benefits for the average user and possibly redesign a technology that was aimed to the previous segments (the technology at first is designed to satisfy the innovators, then the early adopters and only later the early majority) .
The early majority usually adopts after a comparison between the pros and cons, cost and benefits. Reducing the cost could be useful to reach this vast segment, but this should not burn the value of the experience. If the experience loses value, diffusion may fail.

Rogers market segments

	Individuals	Companies
Innovators	If this technology has an additional cost, innovators could be wealthy individuals that can afford new cars with costly features. Some people could be enthusiast of this technology but it may happen that they can’t afford it. On the other hand, this technology could be included for free/with a small surcharge, but even in this case, if interested innovators have already bought a new car, it could be difficult to purchase a new one just for this technology, even if the “nerds” are passionate about this technology. Another option could be that car manufacturers just update the software in existing cars if the proper hardware is already present, making this process cheaper for the users.	Gas station: having a system that supports this technology means less time spent on payments and, consequently, more cars served in the same period of time.
Early Adopters	This segment is similar to the previous one. If this technology is embedded in less exclusive cars or it is less expensive overall for the end user, people that were at the beginning discouraged to adopt it because of the cost, may start using it. This is usually the segment that makes possible and activate the mechanism of diffusion. Since this segment is larger than that of innovators, we could see more reviews, opinions that may or may not help diffusion.	Companies that uses Drive-in/Drive-through: in these cases, having a system that can accept payments made with cars could speed up the services.
Early Majority	If technology diffuses and most of the cars embed it, more customers are reached. This segment is represented by people that don’t have a particular interest and are not passionate about this technology. They usually compare among different possibilities thinking about pros and cons before buying a certain product/service. To be able to reach them, it is also necessary to have an adequate cost, usually less than that available for innovators and early adopters.	E-commerce sites: the driver can buy goods using his voice while driving. Car park companies: entries and exits can be monitored automatically and, consequently, the bill can be automatically calculated.

Abernathy Utterback model for Embedded systems





STATE OF TECHNOLOGIES

- The main technologies required (4g/5g, BLE, RFID) are already individually very performant.
- The time taken for transactions in Visa embedded method already beat the time taken for same transaction through smartphone or credit cards and are almost instantaneous.
- The key point still missing is the availability of shops, toll boots, fuel station and parkings allowing this type of payment.

DIFFUSION

According to Juniper Research the value of embedded in-vehicle payments in 2020 is around 543 million $ and will reach 86 billion $ in 2025. This is still just a fraction of the 212 billion $ spent by drivers in their cars in 2019, according to PYMNTS. The road is still long for this kind of solution, so we could say that in-vehicle embedded payments are between the incubation and the beginning of diffusion phase.

Race for dominant design

Which are the candidates?

- Integrated solutions start well ahead since they exploit smartphones which are already massively diffused.
- Embedded systems have on their part a potential overall better user experience.

Key Factors

- Toll booths owners and Gas station companies can choose which technology to implement in their utilities.
  Some of them like Texaco and Shell are investing in embedded-type solutions.
- Car manufacturers can decide as well which paradigm to insert in their products and are investing a lot in designing their own solution. For example Hyundai, Daimler, Honda are working on embedded systems.

Who will win?

Since a lot of key companies are adopting an embedded choice, with all probabilities their customers will do so. This will pull companies to increase the performances and then the technology will diffuse.
For all these reason we think that the embedded solution will emerge as the dominant design.

Lock-In Effect

How strong is this lock in effect?

Very strong.

Purchasing a new car is not an easy decision. On the other hand changing cell phones which integrate into your car is much more simple.

How can it be overcome?

Companies need to make these new technologies more easily accessible with no new big purchases.

For instance, they could roll out new software updates in order to introduce in-vehicle payment as a technology into a car that has already been purchased.

Lock-In Effect

What could be the moves that companies could propose to overcome the lock in?

A strategy they could propose could be to make their car incompatible with the existing integrated technologies. This is risky because you might alienate some of your consumers.
A better strategy is to offer benefits for using these payment methods. For instance a partnership with an insurance company in order to offer cheaper premiums to customers.
The benefit for the insurance company would be more data on the driver, which could translate into a better strategic position.

Do you think a new lock in might emerge?

It depends on the direction that the technology takes.
If car makers choose to make their vehicles non compatible with integrated systems the lock in might be strong and the same would happen if there are benefits for using the embedded system.

Which standards might play a role?

OS

Integrated systems and embedded systems will need a common operating system to interface with ease with the outside world.

Data regulation

The way in which the different actors process and control the data of their users is already a big deal, specially under GDPR regulations. Companies must conform to standards for data protection, depending on the country in which they operate.

Networking

By far the most important thing is the networking standards adopted.
5G ,4G, bluetooth etc. Are crucial to ensure systems that work universally in all situations.

Cryptography

Crucial component in network standards.
And it is for the same reason that it will play a big role.

Thank You!